Memorandum

To: Charlie Handy, Planner, La Crosse County

From: Nick Semeja, PE, Associate
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Date: July 9, 2021

Subject: La Crosse County – French Island Safety and Mobility Improvements – 2021 RAISE Program Application Benefit-Cost Analysis Memorandum

Introduction

This memorandum summarizes the assumptions, methodology and results developed for the benefit-cost analysis of the No Build and Build Alternatives evaluated as part of the La Crosse County – French Island Safety and Mobility Improvements – 2021 Raise Grant Program Application. The objective of a benefit-cost analysis (BCA) is to bring all the direct effects of a transportation investment into a common measure (dollars), and to account for the fact that benefits accrue over an extended period while costs are incurred primarily in the initial years. The primary elements that can be monetized are travel time, changes in vehicle operating costs, vehicle crashes, environmental impacts, capital costs and remaining capital value, and maintenance costs. The benefit-cost analysis can provide an indication of the economic desirability of an alternative, but decision-makers must weigh the results against other considerations, effects, and impacts of the project.

The focus of the project is to connect industrial centers, businesses, and people through sound multimodal transportation planning and engineering, and to safely and efficiently move goods, services and people in and around the La Crosse region. Better access to regional facilities including rail and harbor, interstates, jobs and schools will be realized for all transportation modes. Pedestrian, bicycle and transit accommodations are lacking in this area and La Crosse County will improve these modes of transportation through this project. There is a need for a rail and harbor connection and this project area is a premier candidate for implementing these improvements. The area also experiences flooding and poor drainage, alarming concentrations of Polyfluoroalkyl Substances (PFAS), and stormwater capacity needs to be upgraded in various locations. This project will address all these issues.

Description of Alternatives

The project contains eight different components that are expected to produce utility independently of one another. For the purpose of this analysis, a No Build and Build Alternative were under consideration for each project component.

Component A: Harbor Improvements

The No Build Alternative included leaving the Harbor facility in its current operational state. No impacts to existing operations were assumed. Primary transportation challenges include:

- Improved rail connectivity
- Inefficient operations for freight haulers
- Inadequate salt storage

The proposed project increases the efficiency of freight hauling services at the Harbor. Specific improvements include:

- Construct new 150’ x 300’ salt shed
- Connect two existing rail spurs to allow for additional storage of cars, limit demurrage costs and reduce the number of switches needed to access facility

Component B: Bainbridge Street/County Highway B/Dawson Avenue/Fanta Reed Road Improvements

The No Build Alternative included leaving the roadway facilities in their current geometric and operational state. No impacts to roadway capacity or remaining service life of the facility were assumed. If the pavement on CTH B is not replaced, it is expected that heavy commercial vehicles will have to divert to USH 53 (Rose Street) to the east to get in and out of the commercial shipping area south of CTH B. Primary transportation challenges include:

- “Poor” pavement condition (PASER 3-4) and subbase structure to accommodate heavy vehicles
- Operational and geometrically deficient intersections
- Lack of pedestrian and bicycle accommodations
- Poor access management
- Lack of transit infrastructure

The proposed project increases the efficiency of freight hauling services at the Harbor. Specific improvements include:

- Reconstruct over 2.3 miles of roadways including:
  - 1.9 miles of rural minor arterial roadway along Bainbridge Street/Dawson Avenue/CTH B and Fanta Reed Road
  - 0.3 miles of rural major collector along Fanta Reed Road
- Construct geometric improvements, including roundabouts, at high crash rate or operationally deficient intersections
- Replace full base and improve subgrade of the roadway to accommodate growing heavy truck and freight traffic volumes
- Add pedestrian enhancements including shared-use path, dedicated bike lanes, sidewalk, and crosswalks
- Address access management of private driveways
- Add bump outs at existing transit stops

Component C: La Crosse Regional Airport (LSE) Improvements

The No Build Alternative included leaving LSE in its current operational state. Safety and operational concerns are motivating the proposed improvements. The primary transportation challenge includes:

- Aircraft landing on Runway 31 currently cannot exit the runway until reaching Taxiway C, approximately 3,800 feet from Runway 31 displaced threshold. As a result, small general aviation (GA) aircraft must land and hold short of Runway 18/36, then either cross Runway 18/36 twice, or turn around and back-taxi on Runway 13/31, to reach the south GA hangar area. This alternative would eliminate the need for these additional runway crossings, as well as back-taxiing on Runway 13/31.

The proposed conditions improve safety by reducing conflict points. The designated improvement is to add a 400' mid-field exit taxiway (addresses a key FAA safety concern).

Component D: Electric Vehicle Charging Station

Installation of the EV charging station will showcase La Crosse County's commitment to environmental stewardship and sustainability of meeting the Wisconsin. The No Build Alternative involves operations of the S.M.R.T. Green Line Bus to operate using existing fleet of diesel buses. The primary transportation challenge includes:

- Provide infrastructure to support advancement of electric vehicles

The charging station will enable the Green Line, which runs 303 miles per day, 254 days a year to operate entirely off electricity.

Component E: Fiber Optic Connection

The airport is currently utilizing 25 megabits per second connection. The No Build Alternative assumes that internet connection speeds will remain at a suboptimal service level for the duration of the benefit-cost analysis period. The primary transportation challenge includes:

- Provide faster, more reliable, and more secure technology upgrades to La Crosse Regional Airport

The new service will provide the airport with download speeds up to 20 times faster and allow the facility to expand with the City of La Crosse in the future. IT service and security at the airport will be much more reliable as many tenants utilize the City's VoIP system. Overall benefits of the project include improved communications and operations, increased speed capacity and security, and reduced operating expenses for the La Crosse Regional Airport.

Component F: Copeland Park Sidewalk Installation

There is a sidewalk gap along Copeland Park Drive from the Loggers Stadium to the north picnic shelter. This causes patrons using Copeland Park or attending a baseball game or special event to walk in the road (which also has on street parking) or divert their trip longer distances to access pedestrian facilities, resulting in safety concerns. Primary transportation challenges include:

- Address a significant gap in sidewalk connectivity by installing 1,600' linear feet of sidewalk
- Removes pedestrians from the roadway when moving through the park and when attending special events

The specific improvement includes:

- Install 1,600' linear feet of sidewalk along the western edge of Copeland Park along Copeland Park Drive between Clinton Street and St. Cloud Street

Component G: Copeland Park Pier

The City of La Crosse currently maintains a waitlist of 160+ applicants looking for mooring slips, and Copeland Park is a highly desirable location on the Black River. Primary transportation challenges include:

- Address local need for transient dock space as well as additional mooring slips
- Increase watercraft transportation options, storage, security, and convenience for marina slip owners

The project will provide the following improvements:

- Construct 24 – 24' x 12' marina slips in the Black River adjacent to Loggers Stadium
- Install 856' linear feet of pier access and transient docking (4-8' wide) in a location already owned by the City of La Crosse

The additional marina slips and transient dock will provide the public with direct access to the frequent events taking place in Copeland Park, resulting in more efficient travel to and from their destinations.

Component H: Town of Campbell Watermain Infrastructure

The town of Campbell, located on the north end of French Island, currently operates its water supply on privately owned wells that are contaminated with PFAS. Primary transportation challenges include:

- Minimize construction effects on CTH B traffic while water distribution networks are being implemented.
- Address the issue of PFAS continuously spreading through aquifers and contaminating the town of Campbell's drinking water.
- Eliminate the need for residents to rely on outsourced drinking water.

The project proposes to solve the contaminated drinking water issue by constructing watermain infrastructure. Specific improvements include:

- Construct a municipal water distribution system to eliminate resident's dependency on contaminated privately owned wells.
- Install 10,215' linear feet of ductile iron watermain while the CTH B roadway is under construction to improve watermain infrastructure (mains, valves, hydrants, laterals, etc.)

BCA Methodology

The following section describes the global assumptions used in the benefit-cost analysis and methodologies used to derive costs and benefits specific to each project component:

Global Assumptions

1. **Main Components**: The main components analyzed included:
   - Travel time/delay (vehicle hours traveled – VHT)
   - Operation cost savings
   - Crashes by severity
   - Air quality/emissions
   - Health, transit, and air quality impacts resulting from cycling facilities
   - Initial capital costs: These costs were broken into distinct categories in accordance with service life (consistent with the recommendations of MnDOT Office of Transportation System Management, July 2019[1]) and were applied evenly over the duration of the construction period.
   - Remaining Capital Value: The remaining capital value (value of improvement beyond the analysis period) was considered a benefit and was added to other user benefits.
   - Routine maintenance and rehabilitation costs
2. **Economic Assumptions**: Unless stated otherwise in the individual project component sections, value of time, vehicle operating costs, emissions costs, crash costs, inflation adjustment factors, were obtained and monetized with methods and assumptions consistent with the Benefit Cost Analysis Guidance for Discretionary Grant Programs, dated February 2021[2],. Remaining capital value assumptions were consistent with methods provided in *Recommended remaining capital value factors for use in benefit-cost analysis in SFY 2020*[3], Minnesota Department of Transportation (MnDOT), Office of Transportation System Management, July 2019 (values were adjusted to reflect discount rate). The analysis was completed using an assumed discount rate of seven percent and a base year of 2018.
3. **Calculation of Remaining Capital Value**: Because many components of the initial capital costs have service lives well beyond the analysis periods used for each project evaluation, the remaining capital value was calculated for the Build Alternative components. These values were expressed in terms of 2018 dollars and were added to other project benefits in

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[1] Table 5: http://www.dot.state.mn.us/planning/program/benefitcost.html
[2] https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf
[3] http://www.dot.state.mn.us/planning/program/appendix_a.html

accordance with USDOT guidance. In determining remaining capital value of the initial capital cost, the costs of the Build Alternative were separated into the following categories:

Project components were assumed a service life based on recommendations provided by La Crosse County and other managers of each project.

Component A: Harbor Improvements

The primary benefits quantified for the Harbor Improvements include:

- Operating time savings associated with covering and uncovering salt: the salt shed is expected to remove the need to cover and uncover salt piles each time loading occurs. This process utilizes roughly 250 man-hours of on-site freight staff per year.
- Travel time savings from rail switches: tying the two rail switches would save one switch a week across forty weeks of the year. The reduction in rail switches results in reduced man-hours (three laborers per switch) and engine operating costs (two engines per switch). Rail switch information was provided by F.J. Robers Co, Inc., who operates the transload facility at the Harbor.

This analysis assumed that construction would take place during year 2022. Therefore, year 2023 was assumed to be the first full year that benefits will be accrued from the project. The expected service lives of the Harbor Improvements vary from sixty years to twelve years. The BCA used the minimum twelve-year analysis period from 2023 to 2034 and calculated remaining capital value for the components with a longer service life. The present value of all benefits and costs was calculated using 2019 as the year of current dollars.

Factors not quantified in the analysis that have potential to produce additional benefits include:

- Operating costs from engine wear and tear.
- Emissions benefits associated reduced truck and train engine use.
- Safety benefits due to reduced site congestion.

Component B: Bainbridge Street/County Highway B/Dawson Avenue/Fanta Reed Road Improvements

The primary benefits quantified for the CTH B and Fanta Reed Road Improvements include:

- Cycling health and air quality benefits: the addition of a shared path along CTH B will serve as a critical connection to greater areas of La Crosse County. Cycling benefits were produced through analysis performed in *Cycle La Crosse, Economic Impact Analysis of a Better Bikeway Network*[4]. Cycling benefits were produced for the entirety of the proposed bike network:
    - $194-$202 million in health benefits (over 20 years)
    - $60-$69 million in transit and air quality benefits (over 20 years)
    - $27 million in economic and property benefits (over 20 years)

  These benefits were prorated based on the number of bike facility miles proposed for CTH B (1.5 miles) compared to the total proposed bikeway network (40.2 miles). Economic and property benefits were excluded for the BCA and the lower of the two values for the

[4] https://projects.srfconsulting.com/Build/La_Crosse/ReportEconomicImpactofBicyclinginLaCrosse.pdf

ranges in health and transit/air quality benefits were used to keep the estimate of benefits conservative.

- Cycling crash cost reductions: the addition of a shared path is expected to lower the risk of bicycle/vehicle collisions. There was one such crash of unknown severity observed in the crash analysis timeframe from years 2011 through 2019. Reduction in crashes was estimated by applying a crash modification factor for a shared path obtained from CMF Clearinghouse[5].
- Intersection crash cost reductions: changes in crashes by severity were also calculated at the intersections being converted to roundabouts:
  - CTH B and Clinton Street
  - CTH B and Fanta Reed Road

  Five-year crash data from years 2015-2019 was collected at both locations to determine annual number of crashes by severity. Reductions in crashes were estimated by applying a crash modification factor for conversion of an intersection to a single-lane roundabout obtained from CMF Clearinghouse[6].
- Operating cost and travel time reductions from freight diversion: based on recommendations provided by La Crosse County maintenance staff, it was assumed that if the roadways are not reconstructed by year 2022 heavy commercial traffic would have to divert to the east on USH 53 to travel to/from the commercial shipping area on the south end of French Island. It was also assumed diversion would only have an adverse effect on travel times and miles traveled for trips traveling to/from I-90 west of the project area. Thus, AADTs were collected using the WisDOT Traffic Count Map[7] on northwest, northeast, and southeast destinations from CTH B to determine the percentage of truck trips on CTH B that use I-90 west of the project area. Google Maps was then used to estimate the additional travel distance and travel time associated with the diversion to determine total benefits. Travel time savings were quantified separately for freight and the truck drivers. The value of freight travel time was obtained for light goods vehicles from Table 5.2.7-4 from Victoria Transport Policy Institute, *Transportation Cost and Benefit Analysis II – Travel Time Costs.*[8] Appropriate adjustments were made to covert the value of freight to year 2019 US dollars. Note that existing traffic volumes were used across all years of the BCA. This can be considered a conservative estimate of benefits assuming traffic volumes will likely grow over time.
- Travel time savings: Intersection delay reduction due to the conversion to single lane roundabouts. Intersection delay calculations were determined using data and assumptions outlined in the Clinton Street to Lakeshore Drive Traffic & Safety Study (March 2021)[9]. Travel Time Savings associated with intersection improvements were calculated for year 2020 and year 2045 AM and PM Peak Hour Turning Movement Volumes. Benefits for the years between 2020 and 2040 were interpolated using an annual growth rate, and benefits for years beyond 2040 were extrapolated using the same growth rate.

This analysis assumed that construction would take place during year 2021. Therefore, year 2024 was assumed to be the first full year that benefits will be accrued from the project. The expected service

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[5] http://www.cmfclearinghouse.org/detail.cfm?facid=9250
[6] http://www.cmfclearinghouse.org/detail.cfm?facid=4924
[7] https://wisconsindot.gov/Pages/projects/data-plan/traf-counts/default.aspx
[8] https://www.vtpi.org/tca/tca0502.pdf
[9] Pages pertaining to intersection delay are included in the Appendix

life of the roadway improvements is thirty years, and the analysis focused on the estimated benefits for the twenty-year period from 2024 to 2043. The present value of all benefits and costs was calculated using 2019 as the year of current dollars.

Factors not quantified in the analysis that have potential to produce additional benefits include:

- Intensified maintenance and rehabilitation activities necessary under the No Build Alternative to keep the roadways open to traffic.
- Travel time savings associated with intersection delay reduction due to the conversion to single lane roundabouts were not quantified for off-peak hours.

Component C: La Crosse Regional Airport (LSE) Improvements

The primary benefits quantified in this benefit-cost analysis for the La Crosse Regional Airport improvements include:

- Travel time savings: reduction in travel time associated with taxiway improvements. The estimated time savings per flight using the improved runway is 2.5 minutes. This value was obtained from La Crosse Regional Airport staff. Value of passenger travel time was obtained from the Airport Cooperative Research Program[10]. Values were inflated to year 2019 dollars using the GDP price deflators provided in the USDOT BCA guidance.
- Fuel savings: reduction in fuel costs associated with taxiway improvements. The estimated annual reduction of jet fuel is 625 gallons. This value was obtained from the La Crosse Regional Airport staff. This estimate assumed that 4,850 feet of travel distance is reduced with the improvement per landing at an average speed of 23 miles per hour. This saves 2.5 minutes per flight. The estimate also assumed an average fuel burn rate of 10 gallons of fuel per hour and 1,500 flights per year.
- Air quality savings: reduction in emissions associated with taxiway improvements. The mass of carbon dioxide emitted per gallon of jet fuel was 9.57 kilograms[11]. Savings in carbon dioxide emission damages were calculated using Carbon emission costs obtained from Benefit-Cost Analysis Guidance for Discretionary Grant Programs - February 2021.

This analysis assumed that construction would take place during year 2022. Therefore, year 2023 was assumed to be the first full year that benefits will be accrued from the project. The expected service life of the taxiway improvements are thirty years, and the analysis focused on the estimated benefits for the twenty-year period from 2023 to 2042. The present value of all benefits and costs was calculated using 2019 as the year of current dollars.

The benefit-cost analysis did quantify all potential benefits that are likely to be realized by users. Safety was a primary motivating factor for the proposed improvements. Improving safety operations at the La Crosse Regional Airport offers direct benefits in the form of savings in total crash costs. Due to a lack of adequate data, these benefits were not captured. However, mitigation of potential crashes would be highly beneficial considering the relatively high cost aviation crashes produce.

A secondary, and potentially far greater benefit of improving safety operations is a reduction in the need to use firefighting foams in the event of an aviation accident. This non-monetized benefit is

[10] All-purpose travel from page 12 was applied: http://onlinepubs.trb.org/onlinepubs/webinars/180913.pdf
[11] Kg of Carbon Dioxide Per gal of Jet Fuel - Table 1 https://www.eia.gov/environment/emissions/co2_vol_mass.php

substantial because PFAS contamination associated with firefighting foam use at this airport has already rendered water undrinkable for residents in the area.

Any further PFAS contamination would likely cause substantial and potentially irreversible environmental, economic, and personal damages in the community. Highlighted in a recent NPR[12] article addressing an ongoing lawsuit between the City of La Crosse and manufactures of firefighting foams which contain PFAS: "when wells are affected by PFAS, damages can range up to $10 million per well, according to Paul Napoli, the city's co-lead counsel. He added that the cost to remediate the airport and surrounding property could be tens of millions, if not up to $100 million."

As the magnitude of PFAS damages to this community are becoming better understood, safety improvements at the La Crosse Regional Airport are a critical solution to mitigate further contamination. The cost of damages associated with these concerns should be taken into consideration when evaluating the potential project benefits.

Component D: Electric Vehicle Charging Station

The primary benefits quantified for the Electric Vehicle Charging Station:

- Savings associated with reduction in vehicle operating costs: annual reduction in vehicle operating costs in diesel vs electric bus service. A case study of a University in South Carolina's bus network noted the vehicle operating costs per mile in their diesel fleet to be $1.53/mile. The vehicle operating cost of a vehicle in the electric fleet was noted to be $0.55/mile.[13]
- Vehicle miles traveled calculations were used to determine emissions savings considering diesel operated buses emit notably more emissions than electric buses. Emission rates were obtained from the Environmental Protection Agency's Motor Vehicle Emission Simulator (MOVES) version 3[14]. The change in emissions between No Build and Build conditions are derived from impact of the EV charging station which enables operation of the S.M.R.T. Green Line (changes diesel bus services to EV bus services). The Green Line Runs 254 days per year and travels a total of 303 miles each day[15]. The change in VMT was applied to emission rates by vehicle type.

Factors not quantified in the analysis that have potential to produce additional benefits include:

- Development of "Sense of Place" by prioritizing the "Scenic Route"
- Promotes "Green Initiatives"

This analysis assumed that construction would take place during year 2020 for a duration of 3 years. Therefore, year 2023 was assumed to be the first full year that benefits will be accrued from the project. The expected service life of the Electric Vehicle Charging Station is 10 years, and the analysis focused on the estimated benefits for the ten-year period from 2023 to 2032. The present value of all benefits and costs was calculated using 2019 as the year of current dollars.

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[12] Press Release on Local impacts of PFAS Contaminants: https://www.wpr.org/city-la-crosse-files-lawsuit-calling-out-23-companies-pfas-contamination
[13] https://uspirg.org/sites/pirg/files/reports/ElectricBusesInAmerica/US_Electric_bus_scrn.pdf
[14] https://www.epa.gov/moves
[15] S.M.R.T Bus Service Informational Resources: https://ridesmrt.com/

Component E: Fiber Optic Connection

The primary benefits quantified for the Fiber Optics Connection:

- Savings associated with access to high-speed fiber internet: Calculated using a willingness to pay per Mbps download speed and obtained from *Eliciting Consumer Willingness to Pay for Home Internet Service: Closing the Digital Divide in the State of Indiana*[16]. The existing and proposed broadband speed was assumed to be 25 Mbps and 500 Mbps, respectively, and was provided by La Crosse Regional Airport staff. There are currently 440 employees at the airport that will directly benefit from the fiber connection; this number was factored to 802 after a multiplier effect of 1.87 per the 2015 Wisconsin DOT Economic Impact Study[17]. The willingness to pay for the broadband speed increase was multiplied by 802 to estimate annual benefits for the fiber connection. Benefits were kept constant throughout the analysis period, which can be considered conservative.

Factors not quantified in the analysis that have potential to produce additional benefits include:

- Quality of Life Elements

This analysis assumed that construction would take place during year 2022. Therefore, year 2023 was assumed to be the first full year that benefits will be accrued from the project. The expected service life of the Fiber Optic Connection is 25 years, and the analysis focused on the estimated benefits for the twenty-year period from 2023 to 2042. The present value of all benefits and costs was calculated using 2019 as the year of current dollars.

Component F: Copeland Park Sidewalk Installation

Improvements include:

- Safety Benefits: Reduced pedestrian crashes after installation of sidewalk. Crash Modifications Factors[18] were applied to applicable crashes in the project area. Crash cost assumptions for the KABCO scale are consistent with values and methodologies published in the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated February 2021. The safety benefit was quantified for years 2021 and 2040 and interpolated based on an annual growth rate derived from year 2000 and year 2010 populations in the U.S. Decennial Census Data for La Crosse County[19].

Factors not quantified in the analysis that have potential to produce additional benefits include:

- Quality of life elements
- Promotes walkability and "sense of place"

This analysis assumed that construction would take place during year 2022. Therefore, year 2023 was assumed to be the first full year that benefits will be accrued from the project. The expected service

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16
https://www.researchgate.net/publication/338519155_Eliciting_Consumer_Willingness_to_Pay_for_Home_Internet_Service_Closing_the_Digital_Divide_in_the_State_of_Indiana

17 Page 3 of https://wisconsindot.gov/Documents/projects/multimodal/air/atw-eis.pdf

18 BP 29 in https://www.oregon.gov/ODOT/Engineering/Docs_TrafficEng/CRF-Appendix.pdf

19 https://www.census.gov/quickfacts/lacrossecountywisconsin

life of the Sidewalk is 25 years, and the analysis focused on the estimated benefits for the twenty-year period from 2023 to 2042. The present value of all benefits and costs was calculated using 2019 as the year of current dollars.

Component G: Copeland Park Pier

The primary benefits quantified for the Copeland Park Pier include:

- Travel Time Savings associated with "waiting, standing & transfer time" and the time savings associated with the inter-modal transfer time at boat launches due to the construction of 24 new boat slips. The hourly value of travel time savings associated with "waiting, standing & transfer time" of $33.00 per hour were valued in accordance with the Benefit-Cost Analysis Guidance for Discretionary Grant Programs - February 2021. The total number of trips per year assume 1 boat trip per week between May and September (22 total trips). An assumption of 1 hour of total delay was associated with "Waiting, Standing & Transfer Time" (minutes): Set up Trailer, Launch/Load Boat, Remove Trailer (Including Parking). Localized data on boat occupancy obtained from the DNR suggests the Average Mississippi River Boating Party size is 2.9 people per boat[20].

Factors not quantified in the analysis that have potential to produce additional benefits include:

- Quality of life: "sense of place" – explore La Crosse
- Improved safety & operations at nearby public boat launches
- Environmental impacts: reduced erosion and spread of invasive species at boat launch
- Vehicle operating cost & reduced emissions associated with not towing boats to boat launch

This analysis assumed that construction would take place during years 2021 and 2022. Therefore, year 2023 was assumed to be the first full year that benefits will be accrued from the project. The expected service life of the Sidewalk is 25 years, and the analysis focused on the estimated benefits for the twenty-year period from 2023 to 2042. The present value of all benefits and costs was calculated using 2019 as the year of current dollars.

Component H: Town of Campbell Watermain Infrastructure

The primary benefits quantified for the town of Campbell watermain infrastructure include:

- Elimination of need to provide bottled water service: Eliminates costs associated with providing bottled water service for residents ($565,000 Annually).
- Travel time savings: reduction in truck travel time associated with need to provide bottled water service: one driver works 40 hours per week, 52 weeks per year to deliver bottled water service to residents in the town of Campbell.
- Annual operating cost savings: reduction in truck travel time associated with need to provide bottled water service: one driver works 40 hours per week, 52 weeks per year to deliver bottled water service to residents in the town of Campbell. The operating cost for the tuck idling was $22.56 per hour.[21]

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[20] Page 5 of https://files.dnr.state.mn.us/aboutdnr/reports/boating/mississippi2003.pdf
[21] Page 3 of https://www.modot.org/sites/default/files/documents/AppendixC1_BCA_TechnicalReport_I-44.pdf

- Air Quality Savings: reduction in emissions associated with reduction in need for bottled water delivery. The mass of carbon dioxide emitted per gallon of gas as 8.89 kilograms[22]. Savings in Carbon Dioxide emission damages were calculated using Carbon emission costs obtained from Benefit-Cost Analysis Guidance for Discretionary Grant Programs - February 2021.

Factors not quantified in the analysis that have potential to produce additional benefits include:

- Health Damages Associated with PFAS
- Property Value Decline Associated with PFAS
- Environmental Damages Associated with PFAS

This analysis assumed that construction would take place during year 2022. Therefore, year 2023 was assumed to be the first full year that benefits will be accrued from the project. The expected service life of the watermain infrastructure is 100 years, and the analysis focused on the estimated benefits for the twenty-year period from 2023 to 2042. The present value of all benefits and costs was calculated using 2019 as the year of current dollars.

BCA RESULTS

The benefit-cost analysis provides an indication of the economic desirability of a scenario, but results must be weighed by decision-makers along with the assessment of other effects and impacts. Projects are considered cost-effective if the benefit-cost ratio is at least 1.0. The larger the ratio number, the greater the benefits per unit cost. Results of the benefit-cost analysis are shown in for the total project, and for each of the five project components. See Attachment A for the complete benefit-cost analysis workbook.

Table 1 – Total Project Results

	Project Benefits (2019 Dollars)	Initial Capital Cost (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)
No Build vs. Build	$29.42 million	$13.90 million	2.1	$15.51 million

Table 2 – Component A: Harbor Improvements,

	Project Benefits (2019 Dollars)	Initial Capital Cost (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)
No Build vs. Build	$2.51 million	$1.49 million	1.7	$1.02 million

Table 3 – Component B: Bainbridge Street/County Highway B/Dawson Avenue/Fanta Reed Road Improvements

	Project Benefits (2019 Dollars)	Initial Capital Cost (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)

[22] Kg of Carbon Dioxide Per gal of Gas - Table 1 https://www.eia.gov/environment/emissions/co2_vol_mass.php

No Build vs. Build	$18.16 million	$8.67 million	2.1	$9.49 million

Table 4 – Component C: La Crosse Regional Airport (LSE) Improvements

	Project Benefits (2019 Dollars)	Initial Capital Cost (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)
No Build vs. Build	$0.42 million	$1.0 million	0.4	$-0.58 million

Table 5 – Component D: Component D: Electric Vehicle Charging Station

	Project Benefits (2019 Dollars)	Initial Capital Cost (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)
No Build vs. Build	$0.50 million	$0.03 million	14.2	$0.46 million

Table 6 – Component E: Fiber Optic Connection

	Project Benefits (2019 Dollars)	Initial Capital Cost (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)
No Build vs. Build	$0.35 million	$0.20 million	1.7	$0.14 million

Table 7 – Component F: Copeland Park Sidewalk Installation

	Project Benefits (2019 Dollars)	Initial Capital Cost (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)
No Build vs. Build	$1.02 million	$0.41 million	2.5	$0.61 million

Table 8 – Component G: Copeland Park Pier

	Project Benefits (2019 Dollars)	Initial Capital Cost (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)
No Build vs. Build	$0.44 million	$0.41 million	1.1	$0.03 million

Table 9 – Component H Town of Campbell Watermain Infrastructure

	Project Benefits (2019 Dollars)	Initial Capital Cost (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)
No Build vs. Build	$6.02 million	$1.69 million	3.6	$4.33 million

Appendix

Clinton Street to Lakeshore Drive Traffic and Safety Study – Intersection Delay Data

Intersection	
Int Delay, s/veh	10.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	10	15	0	35	5	300	0	25	20	440	50	0
Future Vol, veh/h	10	15	0	35	5	300	0	25	20	440	50	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	Yield	-	-	None	-	-	None
Storage Length	-	-	-	-	-	175	-	-	-	150	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	89	89	89	89	89	89	89	89	89	89	89	89
Heavy Vehicles, %	6	6	6	6	6	6	37	37	37	6	6	6
Mvmt Flow	11	17	0	39	6	337	0	28	22	494	56	0

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1086	1094	56	1092	1083	39	56	0	0	50	0	0
Stage 1	1044	1044	-	39	39	-	-	-	-	-	-	-
Stage 2	42	50	-	1053	1044	-	-	-	-	-	-	-
Critical Hdwy	7.16	6.56	6.26	7.16	6.56	6.26	4.47	-	-	4.16	-	-
Critical Hdwy Stg 1	6.16	5.56	-	6.16	5.56	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.16	5.56	-	6.16	5.56	-	-	-	-	-	-	-
Follow-up Hdwy	3.554	4.054	3.354	3.554	4.054	3.354	2.533	-	-	2.254	-	-
Pot Cap-1 Maneuver	190	210	999	189	214	1021	1352	-	-	1531	-	-
Stage 1	272	301	-	966	855	-	-	-	-	-	-	-
Stage 2	962	845	-	269	301	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	93	142	999	130	145	1021	1352	-	-	1531	-	-
Mov Cap-2 Maneuver	93	142	-	130	145	-	-	-	-	-	-	-
Stage 1	272	204	-	966	855	-	-	-	-	-	-	-
Stage 2	640	845	-	167	204	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	45.2	14.5	0	7.6
HCM LOS	E	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	WBLn2	SBL	SBT	SBR
Capacity (veh/h)	1352	-	-	117	132	1021	1531	-	-
HCM Lane V/C Ratio	-	-	-	0.24	0.34	0.33	0.323	-	-
HCM Control Delay (s)	0	-	-	45.2	45.7	10.3	8.5	-	-
HCM Lane LOS	A	-	-	E	E	B	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0.9	1.4	1.5	1.4	-	-

Intersection												
Int Delay, s/veh	9.5											
Movement	**EBL**	**EBT**	**EBR**	**WBL**	**WBT**	**WBR**	**NBL**	**NBT**	**NBR**	**SBL**	**SBT**	**SBR**
Lane Configurations												
Traffic Vol, veh/h	5	15	0	20	20	370	5	45	30	320	20	5
Future Vol, veh/h	5	15	0	20	20	370	5	45	30	320	20	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	Yield	-	-	None	-	-	None
Storage Length	-	-	-	-	-	175	-	-	-	150	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	1	1	1	3	3	3	1	1	1	4	4	4
Mvmt Flow	5	16	0	22	22	398	5	48	32	344	22	5

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	798	803	25	795	789	64	27	0	0	80	0	0
Stage 1	713	713	-	74	74	-	-	-	-	-	-	-
Stage 2	85	90	-	721	715	-	-	-	-	-	-	-
Critical Hdwy	7.11	6.51	6.21	7.13	6.53	6.23	4.11	-	-	4.14	-	-
Critical Hdwy Stg 1	6.11	5.51	-	6.13	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.11	5.51	-	6.13	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.509	4.009	3.309	3.527	4.027	3.327	2.209	-	-	2.236	-	-
Pot Cap-1 Maneuver	305	318	1054	304	322	998	1593	-	-	1505	-	-
Stage 1	424	437	-	933	831	-	-	-	-	-	-	-
Stage 2	925	822	-	417	433	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	141	245	1054	238	248	998	1593	-	-	1505	-	-
Mov Cap-2 Maneuver	141	245	-	238	248	-	-	-	-	-	-	-
Stage 1	423	337	-	930	829	-	-	-	-	-	-	-
Stage 2	540	820	-	306	334	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	24.4	12.2	0.5	7.5
HCM LOS	C	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	WBLn2	SBL	SBT	SBR
Capacity (veh/h)	1593	-	-	207	243	998	1505	-	-
HCM Lane V/C Ratio	0.003	-	-	0.104	0.177	0.399	0.229	-	-
HCM Control Delay (s)	7.3	0	-	24.4	23	11	8.1	-	-
HCM Lane LOS	A	A	-	C	C	B	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0.3	0.6	1.9	0.9	-	-

HCS7 Roundabouts Report

General Information		Site Information	
Analyst	Alexandria Motl	Intersection	Clinton and Bainbridge
Agency or Co.	GRAEF	E/W Street Name	Clinton Street
Date Performed	8/12/2020	N/S Street Name	Bainbridge Street
Analysis Year	2020	Analysis Time Period (hrs)	0.25
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.89
Project Description	CTH B	Jurisdiction	Campbell

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	10	15	0	0	35	5	300	0	0	25	20	0	440	50	0
Percent Heavy Vehicles, %	6	6	6	6	6	6	6	6	37	37	37	37	6	6	6	6
Flow Rate (v_{PCE}), pc/h	0	12	18	0	0	42	6	357	0	0	38	31	0	524	60	0
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.2000			4.2000			4.2000			4.2000	
Follow-Up Headway (s)		2.8000			2.8000			2.8000			2.8000	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		30.00			405.00			69.00			584.00	
Entry Volume veh/h		28.30			382.08			50.36			550.94	
Circulating Flow (v_c), pc/h	626			50			554			48		
Exiting Flow (v_{ex}), pc/h	573			6			407			102		
Capacity (c_{pce}), pc/h		790.12			1236.67			835.63			1238.60	
Capacity (c), veh/h		745.39			1166.67			609.95			1168.49	
v/c Ratio (x)		0.04			0.33			0.08			0.47	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		5.2			6.2			6.8			8.2	
Lane LOS		A			A			A			A	
95% Queue, veh		0.1			1.4			0.3			2.6	
Approach Delay, s/veh	5.2			6.2			6.8			8.2		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	7.3						A					

HCS7 Roundabouts Report

General Information		Site Information	
Analyst	Alexandria Motl	Intersection	Clinton and Bainbridge
Agency or Co.	GRAEF	E/W Street Name	Clinton Street
Date Performed	8/12/2020	N/S Street Name	Bainbridge Street
Analysis Year	2020	Analysis Time Period (hrs)	0.25
Time Analyzed	PM Peak Hour	Peak Hour Factor	0.93
Project Description	CTH B	Jurisdiction	Campbell

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	5	15	0	0	20	20	370	0	5	45	30	0	320	20	5
Percent Heavy Vehicles, %	1	1	1	1	3	3	3	3	1	1	1	1	4	4	4	4
Flow Rate (v_{PCE}), pc/h	0	5	16	0	0	22	22	410	0	5	49	33	0	358	22	6
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.2000			4.2000			4.2000			4.2000	
Follow-Up Headway (s)		2.8000			2.8000			2.8000			2.8000	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		21.00			454.00			87.00			386.00	
Entry Volume veh/h		20.79			440.78			86.14			371.15	
Circulating Flow (v_c), pc/h	402			59			379			49		
Exiting Flow (v_{ex}), pc/h	407			33			464			44		
Capacity (c_{pce}), pc/h		940.49			1228.05			957.47			1237.64	
Capacity (c), veh/h		931.18			1192.28			947.99			1190.03	
v/c Ratio (x)		0.02			0.37			0.09			0.31	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		4.1			6.6			4.6			5.9	
Lane LOS		A			A			A			A	
95% Queue, veh		0.1			1.7			0.3			1.3	
Approach Delay, s/veh	4.1			6.6			4.6			5.9		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	6.1						A					

Intersection	
Int Delay, s/veh	13.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	10	15	0	40	5	345	0	30	25	505	55	0
Future Vol, veh/h	10	15	0	40	5	345	0	30	25	505	55	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	Yield	-	-	None	-	-	None
Storage Length	-	-	-	-	-	175	-	-	-	150	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	89	89	89	89	89	89	89	89	89	89	89	89
Heavy Vehicles, %	6	6	6	6	6	6	37	37	37	6	6	6
Mvmt Flow	11	17	0	45	6	388	0	34	28	567	62	0

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1247	1258	62	1253	1244	48	62	0	0	62	0	0
Stage 1	1196	1196	-	48	48	-	-	-	-	-	-	-
Stage 2	51	62	-	1205	1196	-	-	-	-	-	-	-
Critical Hdwy	7.16	6.56	6.26	7.16	6.56	6.26	4.47	-	-	4.16	-	-
Critical Hdwy Stg 1	6.16	5.56	-	6.16	5.56	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.16	5.56	-	6.16	5.56	-	-	-	-	-	-	-
Follow-up Hdwy	3.554	4.054	3.354	3.554	4.054	3.354	2.533	-	-	2.254	-	-
Pot Cap-1 Maneuver	147	168	992	146	171	1010	1345	-	-	1516	-	-
Stage 1	223	255	-	955	847	-	-	-	-	-	-	-
Stage 2	952	835	-	220	255	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	62	105	992	92	107	1010	1345	-	-	1516	-	-
Mov Cap-2 Maneuver	62	105	-	92	107	-	-	-	-	-	-	-
Stage 1	223	160	-	955	847	-	-	-	-	-	-	-
Stage 2	583	835	-	123	160	-	-	-	-	-	-	-

Approach	EB			WB			NB			SB		
HCM Control Delay, s	70.2			19.1			0			7.9		
HCM LOS	F			C								

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	WBLn2	SBL	SBT	SBR
Capacity (veh/h)	1345	-	-	82	93	1010	1516	-	-
HCM Lane V/C Ratio	-	-	-	0.343	0.544	0.384	0.374	-	-
HCM Control Delay (s)	0	-	-	70.2	82.5	10.8	8.8	-	-
HCM Lane LOS	A	-	-	F	F	B	A	-	-
HCM 95th %tile Q(veh)	0	-	-	1.3	2.4	1.8	1.8	-	-

Intersection	
Int Delay, s/veh	10

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	5	15	0	20	20	420	5	50	35	360	25	5
Future Vol, veh/h	5	15	0	20	20	420	5	50	35	360	25	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	Yield	-	-	None	-	-	None
Storage Length	-	-	-	-	-	175	-	-	-	150	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	93	93	93	93	93	93	93	93	93	93	93	93
Heavy Vehicles, %	1	1	1	3	3	3	1	1	1	4	4	4
Mvmt Flow	5	16	0	22	22	452	5	54	38	387	27	5

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	898	906	30	895	889	73	32	0	0	92	0	0
Stage 1	804	804	-	83	83	-	-	-	-	-	-	-
Stage 2	94	102	-	812	806	-	-	-	-	-	-	-
Critical Hdwy	7.11	6.51	6.21	7.13	6.53	6.23	4.11	-	-	4.14	-	-
Critical Hdwy Stg 1	6.11	5.51	-	6.13	5.53	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.11	5.51	-	6.13	5.53	-	-	-	-	-	-	-
Follow-up Hdwy	3.509	4.009	3.309	3.527	4.027	3.327	2.209	-	-	2.236	-	-
Pot Cap-1 Maneuver	261	277	1047	260	281	986	1587	-	-	1490	-	-
Stage 1	378	397	-	923	824	-	-	-	-	-	-	-
Stage 2	915	813	-	371	393	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	104	204	1047	196	207	986	1587	-	-	1490	-	-
Mov Cap-2 Maneuver	104	204	-	196	207	-	-	-	-	-	-	-
Stage 1	377	294	-	920	822	-	-	-	-	-	-	-
Stage 2	481	811	-	260	291	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	30.2	13.1	0.4	7.6
HCM LOS	D	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	WBLn2	SBL	SBT	SBR
Capacity (veh/h)	1587	-	-	164	201	986	1490	-	-
HCM Lane V/C Ratio	0.003	-	-	0.131	0.214	0.458	0.26	-	-
HCM Control Delay (s)	7.3	0	-	30.2	27.7	11.7	8.3	-	-
HCM Lane LOS	A	A	-	D	D	B	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0.4	0.8	2.4	1	-	-

HCS7 Roundabouts Report

General Information		Site Information	
Analyst	Alexandria Motl	Intersection	Clinton and Bainbridge
Agency or Co.	GRAEF	E/W Street Name	Clinton Street
Date Performed	8/12/2020	N/S Street Name	Bainbridge Street
Analysis Year	2045	Analysis Time Period (hrs)	0.25
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.89
Project Description	CTH B	Jurisdiction	Campbell

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	10	15	0	0	40	5	345	0	0	30	25	0	505	55	0
Percent Heavy Vehicles, %	6	6	6	6	6	6	6	6	37	37	37	37	6	6	6	6
Flow Rate (v_{PCE}), pc/h	0	12	18	0	0	48	6	411	0	0	46	38	0	601	66	0
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.2000			4.2000			4.2000			4.2000	
Follow-Up Headway (s)		2.8000			2.8000			2.8000			2.8000	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		30.00			465.00			84.00			667.00	
Entry Volume veh/h		28.30			438.68			61.31			629.25	
Circulating Flow (v_c), pc/h	715			58			631			54		
Exiting Flow (v_{ex}), pc/h	657			6			469			114		
Capacity (c_{pce}), pc/h		737.27			1229.00			787.05			1232.83	
Capacity (c), veh/h		695.54			1159.44			574.49			1163.05	
v/c Ratio (x)		0.04			0.38			0.11			0.54	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		5.6			6.9			7.5			9.4	
Lane LOS		A			A			A			A	
95% Queue, veh		0.1			1.8			0.4			3.4	
Approach Delay, s/veh	5.6			6.9			7.5			9.4		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	8.2						A					

HCS7 Roundabouts Report

General Information

Analyst	Alexandria Motl
Agency or Co.	GRAEF
Date Performed	8/12/2020
Analysis Year	2045
Time Analyzed	PM Peak Hour
Project Description	CTH B

Site Information

Intersection	Clinton and Bainbridge
E/W Street Name	Clinton Street
N/S Street Name	Bainbridge Street
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.93
Jurisdiction	Campbell

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	5	15	0	0	20	20	420	0	5	50	35	0	360	25	5
Percent Heavy Vehicles, %	1	1	1	1	3	3	3	3	1	1	1	1	4	4	4	4
Flow Rate (v_{PCE}), pc/h	0	5	16	0	0	22	22	465	0	5	54	38	0	403	28	6
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.2000			4.2000			4.2000			4.2000	
Follow-Up Headway (s)		2.8000			2.8000			2.8000			2.8000	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		21.00			509.00			97.00			437.00	
Entry Volume veh/h		20.79			494.17			96.04			420.19	
Circulating Flow (v_c), pc/h	453			64			424			49		
Exiting Flow (v_{ex}), pc/h	457			33			524			50		
Capacity (c_{pce}), pc/h		903.92			1223.28			924.54			1237.64	
Capacity (c), veh/h		894.97			1187.65			915.38			1190.03	
v/c Ratio (x)		0.02			0.42			0.10			0.35	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		4.2			7.3			4.9			6.4	
Lane LOS		A			A			A			A	
95% Queue, veh		0.1			2.1			0.4			1.6	
Approach Delay, s/veh	4.2			7.3			4.9			6.4		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	6.6						A					

Intersection	
Int Delay, s/veh	7.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	10	5	235	10	5	5	170	100	25	0	40	5
Future Vol, veh/h	10	5	235	10	5	5	170	100	25	0	40	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	80	80	80	80	80	80	80	80	80	80	80	80
Heavy Vehicles, %	4	4	4	58	58	58	6	6	6	7	7	7
Mvmt Flow	13	6	294	13	6	6	213	125	31	0	50	6

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	626	635	53	770	623	141	56	0	0	156	0	0
Stage 1	53	53	-	567	567	-	-	-	-	-	-	-
Stage 2	573	582	-	203	56	-	-	-	-	-	-	-
Critical Hdwy	7.14	6.54	6.24	7.68	7.08	6.78	4.16	-	-	4.17	-	-
Critical Hdwy Stg 1	6.14	5.54	-	6.68	6.08	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.14	5.54	-	6.68	6.08	-	-	-	-	-	-	-
Follow-up Hdwy	3.536	4.036	3.336	4.022	4.522	3.822	2.254	-	-	2.263	-	-
Pot Cap-1 Maneuver	394	393	1009	258	337	778	1523	-	-	1394	-	-
Stage 1	955	847	-	422	427	-	-	-	-	-	-	-
Stage 2	501	496	-	686	750	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	339	332	1009	159	285	778	1523	-	-	1394	-	-
Mov Cap-2 Maneuver	339	332	-	159	285	-	-	-	-	-	-	-
Stage 1	808	847	-	357	361	-	-	-	-	-	-	-
Stage 2	413	420	-	483	750	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	11.1	22.6	4.5	0
HCM LOS	B	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1523	-	-	901	230	1394	-	-
HCM Lane V/C Ratio	0.14	-	-	0.347	0.109	-	-	-
HCM Control Delay (s)	7.7	0	-	11.1	22.6	0	-	-
HCM Lane LOS	A	A	-	B	C	A	-	-
HCM 95th %tile Q(veh)	0.5	-	-	1.6	0.4	0	-	-

Intersection	
Int Delay, s/veh	9.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	5	5	240	40	5	0	225	35	10	0	80	10
Future Vol, veh/h	5	5	240	40	5	0	225	35	10	0	80	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	3	3	3	12	12	12	5	5	5	1	1	1
Mvmt Flow	6	6	276	46	6	0	259	40	11	0	92	11

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	665	667	98	803	667	46	103	0	0	51	0	0
Stage 1	98	98	-	564	564	-	-	-	-	-	-	-
Stage 2	567	569	-	239	103	-	-	-	-	-	-	-
Critical Hdwy	7.13	6.53	6.23	7.22	6.62	6.32	4.15	-	-	4.11	-	-
Critical Hdwy Stg 1	6.13	5.53	-	6.22	5.62	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.13	5.53	-	6.22	5.62	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	3.608	4.108	3.408	2.245	-	-	2.209	-	-
Pot Cap-1 Maneuver	372	378	955	290	367	996	1470	-	-	1562	-	-
Stage 1	906	812	-	493	493	-	-	-	-	-	-	-
Stage 2	507	504	-	742	791	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	315	309	955	175	300	996	1470	-	-	1562	-	-
Mov Cap-2 Maneuver	315	309	-	175	300	-	-	-	-	-	-	-
Stage 1	741	812	-	403	403	-	-	-	-	-	-	-
Stage 2	409	412	-	524	791	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	11	32.2	6.6	0
HCM LOS	B	D		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1470	-	-	882	183	1562	-	-
HCM Lane V/C Ratio	0.176	-	-	0.326	0.283	-	-	-
HCM Control Delay (s)	8	0	-	11	32.2	0	-	-
HCM Lane LOS	A	A	-	B	D	A	-	-
HCM 95th %tile Q(veh)	0.6	-	-	1.4	1.1	0	-	-

HCS7 Roundabouts Report

General Information / Site Information

Analyst	Alexandria Motl	Intersection	Dawson and Fanta Reed
Agency or Co.	GRAEF	E/W Street Name	Fanta Reed Road
Date Performed	8/12/2020	N/S Street Name	Dawson Avenue
Analysis Year	2020	Analysis Time Period (hrs)	0.25
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.80
Project Description	CTH B	Jurisdiction	Campbell

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	10	5	235	0	10	5	5	0	170	100	25	0	0	40	5
Percent Heavy Vehicles, %	4	4	4	4	58	58	58	58	6	6	6	6	7	7	7	7
Flow Rate (v_{PCE}), pc/h	0	13	7	306	0	20	10	10	0	225	132	33	0	0	54	7
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.2000			4.2000			4.2000			4.2000	
Follow-Up Headway (s)		2.8000			2.8000			2.8000			2.8000	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		326.00			40.00			390.00			61.00	
Entry Volume veh/h		313.46			25.32			367.92			57.01	
Circulating Flow (v_c), pc/h	74			370			20			255		
Exiting Flow (v_{ex}), pc/h	40			242			155			380		
Capacity (c_{pce}), pc/h		1213.80			964.19			1265.87			1054.41	
Capacity (c), veh/h		1167.12			610.25			1194.22			985.43	
v/c Ratio (x)		0.27			0.04			0.31			0.06	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		5.6			6.4			5.9			4.2	
Lane LOS		A			A			A			A	
95% Queue, veh		1.1			0.1			1.3			0.2	
Approach Delay, s/veh	5.6			6.4			5.9			4.2		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	5.6						A					

HCS7 Roundabouts Report

General Information		Site Information	
Analyst	Alexandria Motl	Intersection	Dawson and Fanta Reed
Agency or Co.	GRAEF	E/W Street Name	Fanta Reed Road
Date Performed	8/12/2020	N/S Street Name	Dawson Avenue
Analysis Year	2020	Analysis Time Period (hrs)	0.25
Time Analyzed	PM Peak Hour	Peak Hour Factor	0.87
Project Description	CTH B	Jurisdiction	Campbell

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	5	5	240	0	40	5	0	0	225	35	10	0	0	80	10
Percent Heavy Vehicles, %	3	3	3	3	12	12	12	12	5	5	5	5	1	1	1	1
Flow Rate (v_{PCE}), pc/h	0	6	6	284	0	51	6	0	0	272	42	12	0	0	93	12
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.2000			4.2000			4.2000			4.2000	
Follow-Up Headway (s)		2.8000			2.8000			2.8000			2.8000	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		296.00			57.00			326.00			105.00	
Entry Volume veh/h		287.38			50.89			310.48			103.96	
Circulating Flow (v_c), pc/h	144			320			12			329		
Exiting Flow (v_{ex}), pc/h	18			290			48			428		
Capacity (c_{pce}), pc/h		1149.49			1002.43			1273.77			995.44	
Capacity (c), veh/h		1116.01			895.03			1213.11			985.58	
v/c Ratio (x)		0.26			0.06			0.26			0.11	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		5.6			4.5			5.3			4.6	
Lane LOS		A			A			A			A	
95% Queue, veh		1.0			0.2			1.0			0.4	
Approach Delay, s/veh	5.6			4.5			5.3			4.6		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	5.3						A					

Intersection	
Int Delay, s/veh	7.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	10	5	270	10	5	5	195	115	30	0	45	5
Future Vol, veh/h	10	5	270	10	5	5	195	115	30	0	45	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	80	80	80	80	80	80	80	80	80	80	80	80
Heavy Vehicles, %	4	4	4	58	58	58	6	6	6	7	7	7
Mvmt Flow	13	6	338	13	6	6	244	144	38	0	56	6

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	716	729	59	882	713	163	62	0	0	182	0	0
Stage 1	59	59	-	651	651	-	-	-	-	-	-	-
Stage 2	657	670	-	231	62	-	-	-	-	-	-	-
Critical Hdwy	7.14	6.54	6.24	7.68	7.08	6.78	4.16	-	-	4.17	-	-
Critical Hdwy Stg 1	6.14	5.54	-	6.68	6.08	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.14	5.54	-	6.68	6.08	-	-	-	-	-	-	-
Follow-up Hdwy	3.536	4.036	3.336	4.022	4.522	3.822	2.254	-	-	2.263	-	-
Pot Cap-1 Maneuver	343	347	1001	214	297	755	1516	-	-	1364	-	-
Stage 1	948	842	-	376	388	-	-	-	-	-	-	-
Stage 2	451	452	-	662	745	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	287	285	1001	120	244	755	1516	-	-	1364	-	-
Mov Cap-2 Maneuver	287	285	-	120	244	-	-	-	-	-	-	-
Stage 1	777	842	-	308	318	-	-	-	-	-	-	-
Stage 2	360	371	-	436	745	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	11.8	28.1	4.5	0
HCM LOS	B	D		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1516	-	-	885	181	1364	-	-
HCM Lane V/C Ratio	0.161	-	-	0.403	0.138	-	-	-
HCM Control Delay (s)	7.8	0	-	11.8	28.1	0	-	-
HCM Lane LOS	A	A	-	B	D	A	-	-
HCM 95th %tile Q(veh)	0.6	-	-	2	0.5	0	-	-

Intersection	
Int Delay, s/veh	10.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	5	5	275	45	5	0	260	40	10	0	90	10
Future Vol, veh/h	5	5	275	45	5	0	260	40	10	0	90	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	3	3	3	12	12	12	5	5	5	1	1	1
Mvmt Flow	6	6	316	52	6	0	299	46	11	0	103	11

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	762	764	109	920	764	52	114	0	0	57	0	0
Stage 1	109	109	-	650	650	-	-	-	-	-	-	-
Stage 2	653	655	-	270	114	-	-	-	-	-	-	-
Critical Hdwy	7.13	6.53	6.23	7.22	6.62	6.32	4.15	-	-	4.11	-	-
Critical Hdwy Stg 1	6.13	5.53	-	6.22	5.62	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.13	5.53	-	6.22	5.62	-	-	-	-	-	-	-
Follow-up Hdwy	3.527	4.027	3.327	3.608	4.108	3.408	2.245	-	-	2.209	-	-
Pot Cap-1 Maneuver	320	333	942	241	322	988	1457	-	-	1554	-	-
Stage 1	894	803	-	442	450	-	-	-	-	-	-	-
Stage 2	455	461	-	714	782	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	263	262	942	132	254	988	1457	-	-	1554	-	-
Mov Cap-2 Maneuver	263	262	-	132	254	-	-	-	-	-	-	-
Stage 1	704	803	-	348	355	-	-	-	-	-	-	-
Stage 2	353	363	-	471	782	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	11.7	48	6.8	0
HCM LOS	B	E		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1457	-	-	864	139	1554	-	-
HCM Lane V/C Ratio	0.205	-	-	0.379	0.413	-	-	-
HCM Control Delay (s)	8.1	0	-	11.7	48	0	-	-
HCM Lane LOS	A	A	-	B	E	A	-	-
HCM 95th %tile Q(veh)	0.8	-	-	1.8	1.8	0	-	-

HCS7 Roundabouts Report

General Information		Site Information	
Analyst	Alexandria Motl	Intersection	Dawson and Fanta Reed
Agency or Co.	GRAEF	E/W Street Name	Fanta Reed Road
Date Performed	8/12/2020	N/S Street Name	Dawson Avenue
Analysis Year	2045	Analysis Time Period (hrs)	0.25
Time Analyzed	AM Peak Hour	Peak Hour Factor	0.80
Project Description	CTH B	Jurisdiction	Campbell

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	10	5	270	0	10	5	5	0	195	115	30	0	0	45	5
Percent Heavy Vehicles, %	4	4	4	4	58	58	58	58	6	6	6	6	7	7	7	7
Flow Rate (v_{PCE}), pc/h	0	13	7	351	0	20	10	10	0	258	152	40	0	0	60	7
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.2000			4.2000			4.2000			4.2000	
Follow-Up Headway (s)		2.8000			2.8000			2.8000			2.8000	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		371.00			40.00			450.00			67.00	
Entry Volume veh/h		356.73			25.32			424.53			62.62	
Circulating Flow (v_c), pc/h	80			423			20			288		
Exiting Flow (v_{ex}), pc/h	47			275			175			431		
Capacity (c_{pce}), pc/h		1208.15			925.26			1265.87			1027.69	
Capacity (c), veh/h		1161.68			585.60			1194.22			960.46	
v/c Ratio (x)		0.31			0.04			0.36			0.07	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		6.0			6.6			6.4			4.3	
Lane LOS		A			A			A			A	
95% Queue, veh		1.3			0.1			1.6			0.2	
Approach Delay, s/veh	6.0			6.6			6.4			4.3		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	6.1						A					

HCS7 Roundabouts Report

General Information		Site Information	
Analyst	Alexandria Motl	Intersection	Dawson and Fanta Reed
Agency or Co.	GRAEF	E/W Street Name	Fanta Reed Road
Date Performed	8/12/2020	N/S Street Name	Dawson Avenue
Analysis Year	2045	Analysis Time Period (hrs)	0.25
Time Analyzed	PM Peak Hour	Peak Hour Factor	0.87
Project Description	CTH B	Jurisdiction	Campbell

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	5	5	275	0	45	5	0	0	260	40	10	0	0	90	10
Percent Heavy Vehicles, %	3	3	3	3	12	12	12	12	5	5	5	5	1	1	1	1
Flow Rate (v_{PCE}), pc/h	0	6	6	326	0	58	6	0	0	314	48	12	0	0	104	12
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.2000			4.2000			4.2000			4.2000	
Follow-Up Headway (s)		2.8000			2.8000			2.8000			2.8000	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		338.00			64.00			374.00			116.00	
Entry Volume veh/h		328.16			57.14			356.19			114.85	
Circulating Flow (v_c), pc/h	162			368			12			378		
Exiting Flow (v_{ex}), pc/h	18			332			54			488		
Capacity (c_{pce}), pc/h		1133.50			965.69			1273.77			958.21	
Capacity (c), veh/h		1100.49			862.23			1213.11			948.73	
v/c Ratio (x)		0.30			0.07			0.29			0.12	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		6.1			4.8			5.7			4.9	
Lane LOS		A			A			A			A	
95% Queue, veh		1.3			0.2			1.2			0.4	
Approach Delay, s/veh	6.1			4.8			5.7			4.9		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	5.7						A					

Attachment A

Benefit-Cost Analysis Worksheet